

from that of the prior art film (e) noted above having a Cu/Au laminate film in that the surface of the Ag film reflects electrons in the latter. In addition, the present invention has solved the problem with the prior art film (d) which loses the reflectivity when Ta is laminated on the surface of the Au film therein. This is because the present invention utilizes the specular reflection on the metal/metal interface, which being characterized in that each film thickness is specifically defined in consideration of the Fermi wavelength of electrons and that the components in the interface do not form solid solution.

In the prior art constitution (d), Ta is laminated on an extremely thin Au layer, of which the thickness is only 0.4 nanometers and is nearly the same as the Fermi wavelength, and Ta will form solid solution with Au. In this, therefore, it is obvious that, even when the Co-Au interface could be reflective, its reflection is lost as a whole. If the thickness of the Au film therein is made larger than the Fermi wavelength, such a thick Au film could be reflective as being influenced little by the interfacial diffusion of Ta thereinto, but, on the other hand, negative influences of shunt current flow on the Au film will be enlarged. In place of the Au/Ta interface as in the prior art constitution, if a laminate film of Au/Cu/Ta in which the Cu layer does not form solid solution with Ta is used, the Au interface is not disturbed in the

laminate. In addition, if an ultra-thin Cu layer is inserted, for example, between the interface of CoFe and Au, long-term diffusion of Au into the nonmagnetic spacer layer could be prevented, and, in addition, the reflectivity of the resulting laminate could be enhanced since the Cu layer having a short Fermi wavelength is interposed between CoFe and Au.

In the embodiments mentioned above, the MR-improving layer is disposed adjacent to the free layer 1 or the antiferromagnetic layer 6. Different from those, other embodiments where the MR-improving layer 4 is disposed inside the free layer 1 or inside the pinned magnetic layer 2, for example, as in Fig. 43, could produce the same results as above.

In the spin valve film 8 of Fig. 43, the free layer 1 is composed of, for example, an NiFe layer 1a and a CoFe layer 1b, and the MR-improving layer 4 of a laminate film of a plurality of metal films 4a and 4b is interposed between the layers 1a and 1b. In this, the NiFe layer 1a and the CoFe layer 1b are ferromagnetically coupled to each other via the MR-improving layer 4 existing therebetween, and those plural layers are integrated and magnetically acts as the integrated free layer 1. Where the MR-improving layer 4 is interposed in the interface of NiFe layer 1a/CoFe layer 1b (in this case, the layer 4 does not form solid solution with both the layers 1a and 1b in the interface), the NiFe layer 1a and the CoFe layer 1b must be integrated to act as the integrated free layer

1. In this case, therefore, the MR-improving layer 4 to be interposed must be thin. The MR-improving layer may also be interposed in the pinned magnetic layer 2. In this case, two or more magnetic films constituting the pinned magnetic layer 2 are ferromagnetically or antiferromagnetically coupled to each other. The mode of ferromagnetic or antiferromagnetic coupling in the layer 2 shall be determined, depending on the material and the thickness of the MR-improving layer 4 to be interposed in the layer 2.

The magnetoresistance effect device of the embodiments mentioned hereinabove may be mounted on separated recording/reproducing magnetic heads, as the reproduction device part, for example, as in Fig. 44 and Fig. 45. Not limited to magnetic heads, the magnetoresistance effect device of the invention is also applicable to other various magnetic memory systems such as magnetoresistance effect memories (MRAM), etc.

Fig. 44 and Fig. 45 show the structures of embodiments of a separated recording/reproducing magnetic head which incorporates the magnetoresistance effect device of the invention as the reproduction device part. These are sectional views of separated recording/reproducing magnetic heads as seen in the medium facing direction.

In those drawings, 21 is a substrate with a layer of  $\text{Al}_2\text{O}_3$ , such as  $\text{Al}_2\text{O}_3\text{:TiC}$ . On the main surface of the substrate 21, formed is a lower magnetic shield layer 22 of a soft magnetic